Comment on “Quantum noise influencing human behaviour could fake effectiveness of drugs in clinical trials”

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Abstract

Here are discussed some problems concerning quant-ph/0208006.

1 Introduction

In the paper [1] it is suggested to consider possibility of influation of quantum effects in every-day life events like clinical studies. If to recall, how difficult and fine may be experiments for testing of quantum nonlocality [2], it is really unexpectedly, how it would be possible to test such kind of results in very complicated area, like clinical studies of real people, there even classical statistical criteria may be applied only with certain limitations. It should be mentioned, that even in precise physical experiments observation of quantum correlations still is under certain investigation [3, 4]. Let us consider a few concrete problems related with models discussed in [1].

2 Physics and Cryptography. (Testing quantum correlation for time-like interval)

It should be mentioned, that first design used in [1] has essential difference with usual experiment [2, 3] and to talk about experimental confirmation is not quite correct.

Such kind of experiments are not performed (yet?) not only because of certain difficulties, but also, because treatment of counterfactual data suggested in [1] is not very common in natural sciences. Let us consider physical model correponding to first kind of trials suggested in [1] Fig. 1.

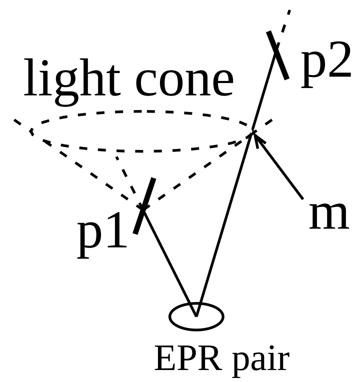

Figure 1: Physical model of suggested in [1] trial

Here should be considered not a simple case, then time gap between events is very small (it would correspond to less accurate earlier tests of quantum nonlocality, then space-like interval between events can be not guaranteed), but as an experiment when between a moment "**m**" (when it is already possible to state, that fist photon was absorbed by detector after first polarizer **p1** and only one photon still exists) and the second measurement **p2** of polarization passed (in laboratory time) even not few days or weeks (as it would be necessary for purposes discussed in [1]), but at least a few seconds.

Such kind of time-like quantum correlation still impracticable and not only because of enormous difficulties, but also due to doubtful possibility of clear interpretation of such experiments: on the one hand it could be considered as strange example of quantum correlations between past and future, between existing and not-existing particle, but there is more simple, usual and mathematically equal model suggesting, that somewhere after moment "**m**," and before measurement **p2** there is only one particle in pure state described by polarization orthogonal to measured by first polarizer **p1**. And finally, there is (again mathematically equivalent) absolutely weird model, that it is future measurement of polarization **p2** influences on first particle and causes it to be in pure state with polarization orthogonal to result of this measurement[1].

[1]On the other hand we may hear sometime, "doctor suggested the pills *because* it will

Problem 1. *Despite of some resemblance, (due to "uncovering secrets of Nature") physics has certain difference with cryptography. It is often not enough to suggest a model that reproduces behavior of some system. One proper key is enough to uncover code, but here often exists many different explanations and some of them may be absurd or completely irrelevant.*

3 Breltmann's pills

Dr. Breltmann[2] [5] recently developed new kind of (quantum®) medicine for curing *suggestibility*, but clinical tests produced absolutely negative result — all patients, who following his advice and used the pills (very bitter) after testing demonstrated, that their level of suggestibility is even higher, than in group of people, who refused to use the tablets. But after such result Dr. Breltmann realized, that the trials anyway demonstrated very strong influence of his pills on human beings and suggested to use it for medical treatment of *obstinacy*. He succeeds this time — clinical trials confirm, that 100% of patients, who agreed to use the pills lately passed a difficult test on completely absence of obstinancy.

The similar example was considered also in [1], but here it is reproduced in such extreme form to recall corresponding Bell consideration: in [5] he discussed classical model of correlation for two spin-1/2 particles, then probabilities of registration are [5]:

$$\left.\begin{array}{l} P(up,up) = P(down,down) = \frac{|a-b|}{2\pi} \\ P(down,up) = P(up,down) = \frac{1}{2} - \frac{|a-b|}{2\pi} \end{array}\right\} \qquad (1)$$

instead of

$$\left.\begin{array}{l} P(up,up) = P(down,down) = \frac{1}{2}\left(\sin\frac{a-b}{2}\right)^2 \\ P(down,up) = P(up,down) = \frac{1}{2} - \frac{1}{2}\left(\sin\frac{a-b}{2}\right)^2 \end{array}\right\} \qquad (2)$$

in quantum case and wrote next [5]:

> "Thus the *ad hoc* model does what is required of it (i.e., reproduces quantum mechanical results) only at $(a-b) = 0$, $(a-b) = \pi/2$ and $(a-b) = \pi$, but not at intermediate angles.

help your," as if future help causes some past event. So even such weird interpretations indirectly present in our reasoning.

[2]Name used by Bell is slightly changed by some reasons.

[...] Could we not be a little more clever, and device a model which reproduces the quantum formulae completely? No. It cannot be done, so long as action at a distance is excluded. This point was realized only subsequently. Neither EPR nor their contemporary opponents were aware of it. Indeed the discussion was for long entirely concentrated on the points $|a-b| = 0$, $\pi/2$ and π."

It should be mentioned, that correlation functions

$$E(a,b) = P(up,up) + P(down,down) - P(down,up) - P(up,down) \quad (3)$$

produced from classical Eq. (1) and quantum Eq. (2) expressions have similar behavior with same minimal value (anticorrelation) for $a-b=0$, maximal (correlation) for $|a-b| = \pi$, an intermediate for $|a-b| = \pi/2$ (see picture in [3]).

Problem 2. *Even for simpler setup with particles and polarizers there are certain problems with distinction between quantum and classical correlations. For much more complicated situation with clinical research such difference may be completely hidden (see below)*

4 Identity of physical systems. Non-identity of patients. What is the spin of patient?

There is yet another property of classical Bell's model discussed above: for any difference between two angles $\Delta = a - b$ there is some value Δ_c that reproduces all probabilities on classical model *for the fixed values of angles*. Three points mentioned by Bell are special case, then $\Delta = \Delta_c$. So we may not say, that quantum correlation are "stronger" than classical as it sometime may be found in not very accurate popular presentations (in quote above even suggested, that it was so for *any* papers before Bell's works).

As it follows from [1], authors are aware about the problem, but in the abstract may be found following sentence:

> "Quantum effects could fake an increase of the recovery rate by about 13% although the drug would hurt as many patients as it would help if everyone took it."

It may cause a wrong conclusion, that quantum correlation may produce additional fake effect, stronger than analogue with classical "Breltmann's placebo pills" discussed earlier. Really in [1] 13% is value of specific expression for collective property of some group of people[3] with different "angular parameters" [1] and so only loosely can be considered as "recovery rate" (it is like situation, then instead of value of blood pressure in clinic you got a puzzle like "your pressure is 0.87 of mine two years ago.")

In [1] also is not discussed an important consequences that may destroy overall idea. In such a model [1] angles a, b are not simply accessible or at least observable parameters like for experiments with polarizers. On the other hand, for any experiment with fixed angles and trial with one particular patient always exists two angles for classical model, that completely reproduce necessary correlations, i.e. arbitrary value between -1 and $+1$.

It is necessary to perform many experiments with particles and four concrete fixed angles, to prove quantum nature of correlation. It is not enough to use only one pair of angles. It is clear also, that we should ensure that each polarizer may have only two given angles. If it may be set in some unknown variety of different angles, then we again may not hope to measure any true correlations.

So model suggested in [1] could work only if all patients may be characterized by the same four fixed angles. Seems the limitation is enough to make the model not very realistic, but here is yet another related point. There is some difference between Eq. (2) above and equations used in [1]. All angles in expressions differ in two times. Really both expressions are valid. The difference is because in [1] used expressions for photon with spin-1, but in [5] for electron with spin-1/2.

So here is rather naive question: even if we accept that quantum model of patient suggested in [1] is true, *what is "a spin of patient"?* Or yet another question, let us suggest, that clinical trial may be described by correlation with some complicated function, not "cos" in [1] and the expression may not be explained neither by classical nor but quantum hidden latent parameters. Could we use the experimental data as a proof, that we find some new law of physics? That is the difference between such idea and model in [1][4]?

[3]Due to properties of Bell's classical model discussed above, quantum corelations could not be ensured by arbitrary number of trials with fixed parameters, like angles of polarizers.

[4]It was rather pathetic question partially related with suggestion in [1] to use counterfactual statements. It is written, that it is possible, if we have a model. But we may have also a model of new physical law, that explains new kind of correlation function mentioned above, or mathematical model of a nurse-esper, who directly recovered patients without any medicine.

The problem, that we have two different ways to explain some phenomenon (recovering of patients): with direct causal effects of medicine and without it, but with latent quantum phenomena. It is not clear, how to distinguish those and why we should accept rather vague quantum model developed in [1]. So ...

Problem 3. *Elementary physical systems are equivalent. This property together with possibility of ideal repetition with same setup of experimental equipment is necessary condition for testing quantum correlations, but it is doubtful, that the same is true for real patients and clinical trials.*

Problem 4. *It is even not such a big flaw to object using classical theory for clinical trials (after all, "classical" is some synonym of "known already to scientists living more than century ago"), but how does it possible to use only simplest models of quantum theory (hardly applicable even to two particles, see above) for very complex beings?*

5 "C^* algebra of patient."

Some problems discussed above was concerned rather with difficulty of observation quantum effects discussed in [1], but it may be not must important problem. Authors of [1] themselves were aware about it and wrote in abstract:

> "We do not present any realistic model showing this effect, we only point out that the physics of decision making could be relevant for the causal interpretation of every-day life statistical data."

and in conclusion:

> ... "Hence the violation of the instrumental inequalities requires quantum coherence that is stable for a long time (compared to time scales of decoherence in technical quantum systems). Therefore the violation seems to be even less likely.
>
> However, the main purpose of this paper was to show that some classical causal interpretations of every-day life statistical data could *in principle* fail if latent quantum effects influence our behavior."

But it was not mentioned rather simple principle:

Problem 5. *There are many absolutely different phenomena described by similar expressions and so resemblance of mathematical formulae should not be considered as proof of equality.*

After all it could be possible to comment some interesting result discussed in [1] as *it is found, that models of linear algebra developed for description of quantum mechanical systems are also convenient for description of decision making in AI and statistics*, but not as an evidence of reducibility of some psychological and physiological processes to quantum entanglement of two particles somewhere inside of human brain (idea about “one-particle entanglement” suggested in [1] even more mysterious).

6 Affine separability. (ZHSL-BCJLPS theorems and fake quantum correlations)

May be pretensions about vague quantum models or irony about spin of patient are not appropriate here? After all in [1] is discussed saturated and detailed C^*-algebraic model of patient and it may include complicated issues of spins or quantum behavior of multi-particle alive systems. But here there is yet another point.

As it was already mentioned in introduction, basic general question related with [1] is: how it is possible in principle to talk about quantum correlations in clinical trials, if even in “refined” condition of usual physical experiments, it is challenging task near limit of accuracy of modern physical equipment? But if we have a complicated mathematical model like in [1], how to check the misgivings about inadequacy?

Seems here may help a rather general result about “affine separability” discussed in [8] and overlapped with earlier applications of *ZHSL-BCJLPS theorem*[5].

More detailed account may be found in original papers [6, 7, 8], but general idea rather simple and shows, that in realistic conditions with weak signal due to quantum effect and big background noise it is not possible to distinguish classical and quantum correlations. Due to such problem in [7] was raised question about legitimacy to talk about quantum effect in real NMR experiments. That can be said in such a case about clinical trials?

The trials considered in [1] are also relevant to error model necessary for wrong interpretation used in [8]. Very close analogue of the models [1] was

[5] Życzkowski, Horodecki, Sanpera, Lewenstein [6] – Braunstein, Caves, Jozsa, Linden, Popescu, Schack [7] theorem.

considered in [10]. It was discussed misclassification of case-control studies[6] due to problems similar with discussed in [1]. The model developed in [8] could not be mentioned in [10], written more earlier, but after developing of this model and even before appearance of [1] it becomes clear, that such a model is relevant not only to physical research, but in more wide area including situations discussed in [10].

The model of error developed in [8] also appropriate to general algebraic framework used in [1], because let show, that using quite simple transformation it is possible to produce "classically correlated state" from arbitrary quantum state and it is relevant also for description of quantum states used in [1] (i.e., some linear functional on a C^* algebra [9]).[7]

The transformation corresponds to distortion of probabilities p_k of some outcomes described as

$$p'_k = sp_k - b. \tag{4}$$

Here coefficients s and b should be connected by simple relation to ensure unit probability for sum of all possible outcomes (see [8]). The equation Eq. (4) may looks strange only at first sight, but it has many realistic applications. For example, it corresponds to linear approximation of a model with arbitrary nonlinear function $p' = f(p)$ or may be rewritten as

$$p' = a\,p - b\,\bar{p}, \quad a = s - b, \quad \bar{p} \equiv 1 - p \tag{5}$$

and the expression produces more clear interpretation of Eq. (4). It corresponds to erroneous reduction of probability estimation due to events of "complimentary"[8] kind.

It should be mentioned also, that Eq. (4) is not necessary related with some error. It may describe true change of probabilities of some processes due to pure classical reason. Let us consider example with two neurons considered in [1]. There was suggested Bell-type correlations between two neurons due to quantum effects. It is strange to use ideas of nonlocality test with special setup ensuring of noninteraction between objects to systems with possibility of active interdependency. For neurons it is very actual, because "saturation of probabilities" discussed in relation with Eq. (5) is very common process here [11] and can be represented by simple scheme of *lateral inhibition* Fig. 2.

[6] Studies discussed in [1] are called so sometime.

[7] It should be mentioned yet, that ZHSL-BCJLPS theorem formally still proved only for finite-dimensional systems, but it is enough for consideration of [1].

[8] In classical sense.

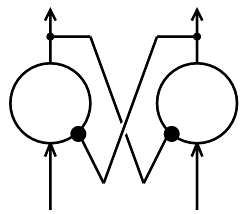

Figure 2: Lateral inhibition

It may be familiar in physical society due to chapter about color vision in first volume of *The Feynman lectures on physics* [12]. Here mathematical problem with physically impossible *negative* value for intensity of red color discussed in [12] has formal resemblance with physically impossible negative probability discussed by Feynman in his first lecture on quantum simulators [13], and it is again an example of mathematically similar and physically different models. Excitations of neurons may be described by models of linear algebra [11] and it is similar with quantum mechanics, but the excitation is result of very difficult chemical processes with many molecules and classical description.

For testing some of these laws are enough simple pictures like Fig. 3.

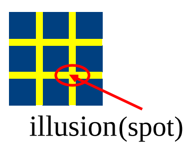

Figure 3: Visual illusion

Problem 6. *The model discussed in [1] is illustrative example of conditions for fake quantum correlations due to errors or wrong interpretation of complicated experimental data recently discussed in [8]. So even appearance of regularity suggested by the models [1] could not confirm quantum correlation due to many unpredictable sources of errors in real clinical trials, because in such conditions criteria for distinction between classical and quantum correlations may not be applied.*

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